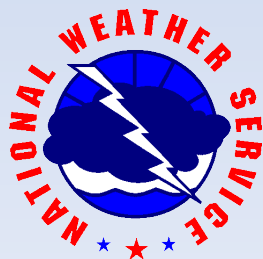


An Overview of Recognizing High Impact Hydro Events

By Richard H. Grumm
WFO State College PA

Facilitators: Brad Grant, Steve Martinaitis



Learning and Performance Targets

Recommendation 12:

Training should be enhanced on the use pattern recognition for extreme events and use of anomaly data and SREF data in the forecast process.



Service Assessment

Record Floods of Greater Nashville: Including Flooding in Middle Tennessee and Western Kentucky, May 1-4, 2010



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland

Learning and Performance Targets

All NWS meteorologists and hydrologists shall be able to:

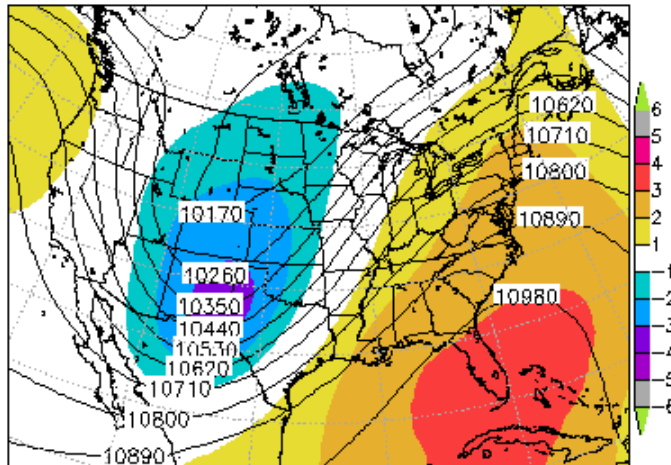
1. Identify role of antecedent conditions in flood events.
2. Show how well standardized anomalies aid in identifying the potential for heavy rain and flooding.
3. Recognize the limits of standardized anomalies in the forecast process and in heavy rainfall events.
4. Show how standardized anomalies and ensembles can provide confidence in forecasting flood events.

Outline

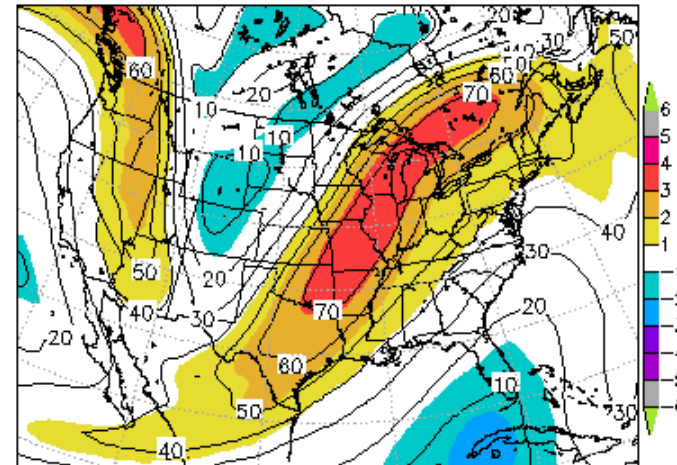
- **Focus on using standardized anomalies**
 - Identify heavy rainfall events that can produce forecasts of heavy/excessive rain
 - Strive for identification of enduring/multi-day events
 - Method can be applied for a spectrum of weather events
- **Ensemble anomalies and QPF**
 - Confidence in a known pattern
 - Provide some information on predictability
- **Future guidance** → Moving toward Extreme Forecast Index (EFI) and alarm maps

Ensembles Provide Anomalies and Confidence in the Outcome of a Pattern

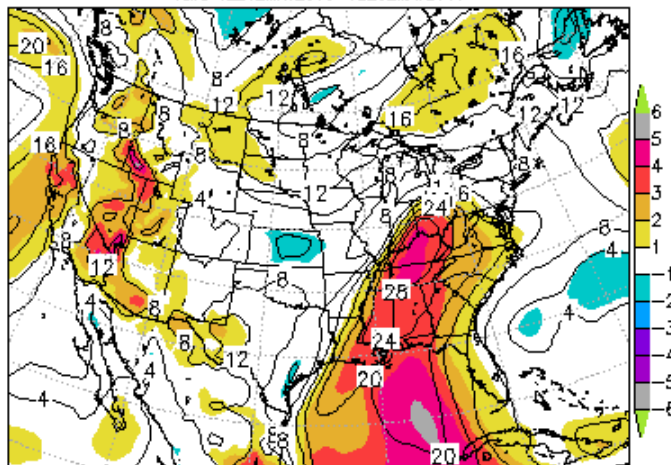
a.09Z30APR2010 SREF hgtprs 250
Valid 12Z02MAY2010-12Z02MAY2010



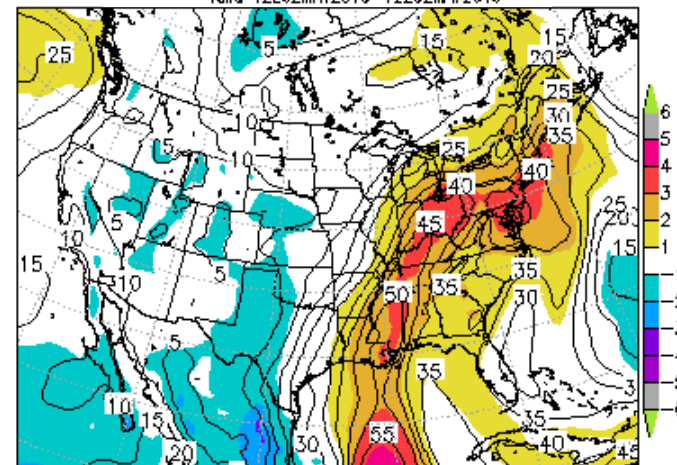
b.09Z30APR2010 SREF wind 250
Valid 12Z02MAY2010-12Z02MAY2010



c.09Z30APR2010 SREF wind 850
Valid 12Z02MAY2010-12Z02MAY2010



d.09Z30APR2010 SREF pwteln 1000
Valid 12Z02MAY2010-12Z02MAY2010



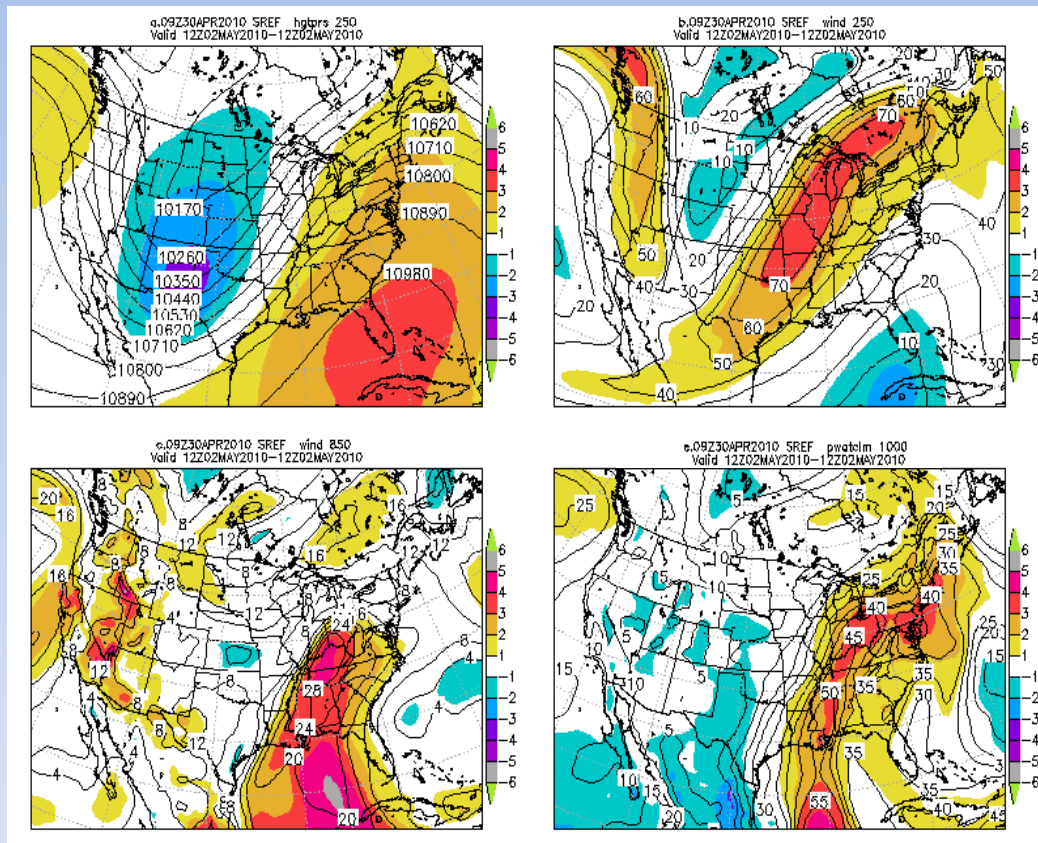
Anomalies, Patterns and Ensembles

How are these related?

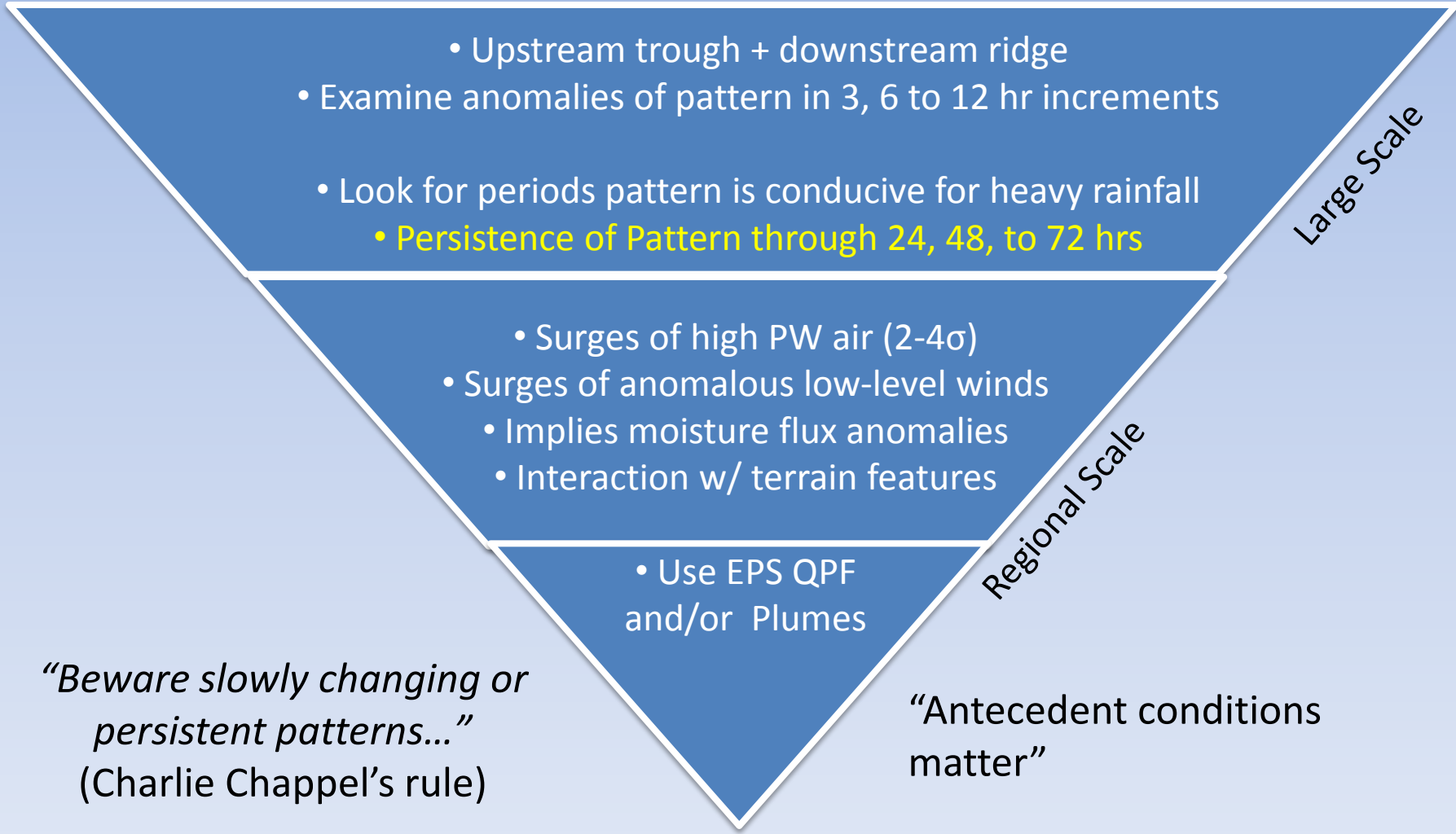
- **Anomalies** and the known **Patterns** distinguish an ordinary from an extraordinary event
- Known **pattern** + large **anomaly** provide confidence in predicting **high impact events**
- **Ensembles** add the **confidence information** related to probability of exceeding a certain QPF or anomaly value

What's the Applicability?

- **Confidence** in the pattern
 - Deep trough and ridge with moisture plume (Atmospheric river)
 - Large PW anomalies with strong low-level winds
- Provide context of pattern (**Maddox Types**)
 - Known pattern with high probability of above normal PW and low-level winds
 - Signal that **this event** could be bigger than most heavy rain events of this type



Forecast Funnel Considerations

- 
- The diagram is an inverted triangle divided into three horizontal sections. The top section is labeled 'Large Scale' on its right side, the middle section is labeled 'Regional Scale' on its right side, and the bottom section is unlabeled. Each section contains a list of considerations for forecasting. The text 'Antecedent conditions matter' is located at the bottom right of the diagram, and the quote 'Beware slowly changing or persistent patterns...' (Charlie Chappel's rule) is at the bottom left.
- Upstream trough + downstream ridge
 - Examine anomalies of pattern in 3, 6 to 12 hr increments
 - Look for periods pattern is conducive for heavy rainfall
 - Persistence of Pattern through 24, 48, to 72 hrs

Large Scale

- Surges of high PW air ($2-4\sigma$)
- Surges of anomalous low-level winds
- Implies moisture flux anomalies
- Interaction w/ terrain features

Regional Scale

- Use EPS QPF and/or Plumes

"Beware slowly changing or persistent patterns..."
(Charlie Chappel's rule)

"Antecedent conditions matter"

A Snap Shot Fade to 24-hour

Persistent heavy rain pattern → Chapell's Rule

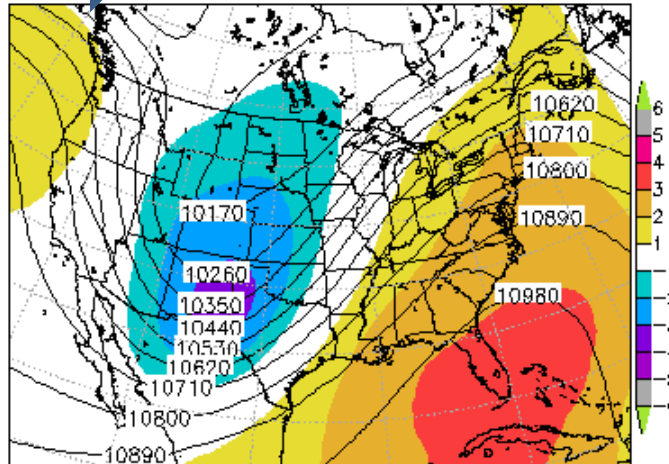
Time of image

Analyze pattern over a 24-hr period (in this case, the period ending at 00 UTC 03 May 2010)

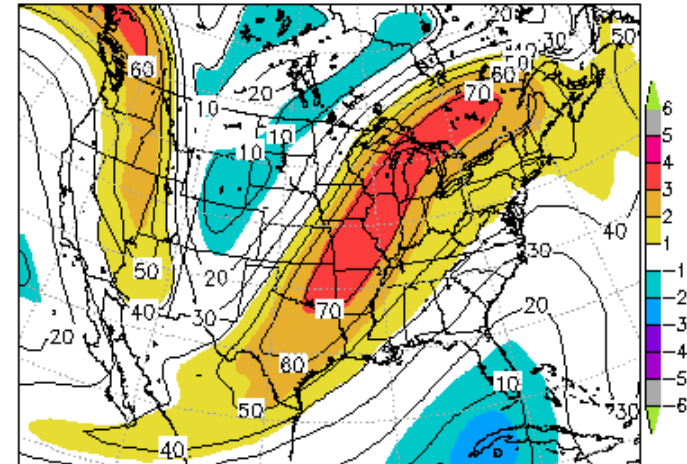
Persistence of a known heavy rainfall pattern



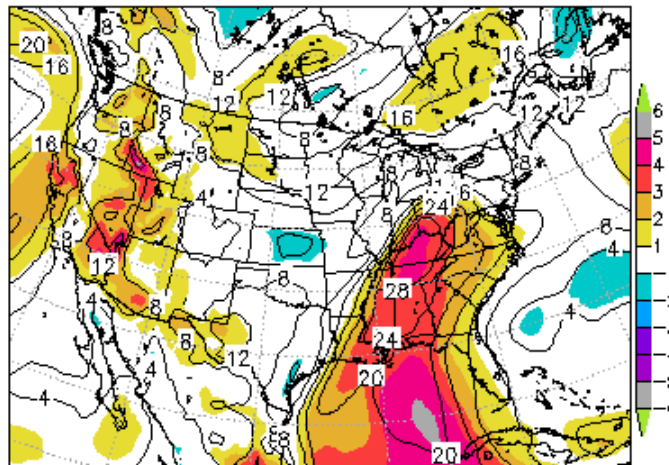
a.09Z30APR2010 SREF hgtprs 250
Valid 12Z02MAY2010-12Z02MAY2010



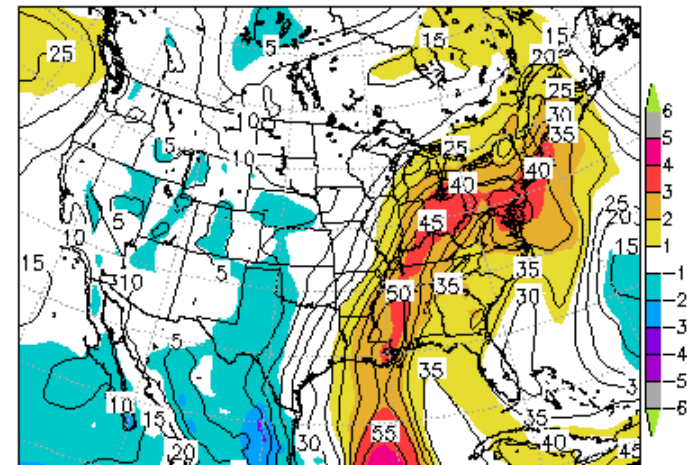
b.09Z30APR2010 SREF wind 250
Valid 12Z02MAY2010-12Z02MAY2010



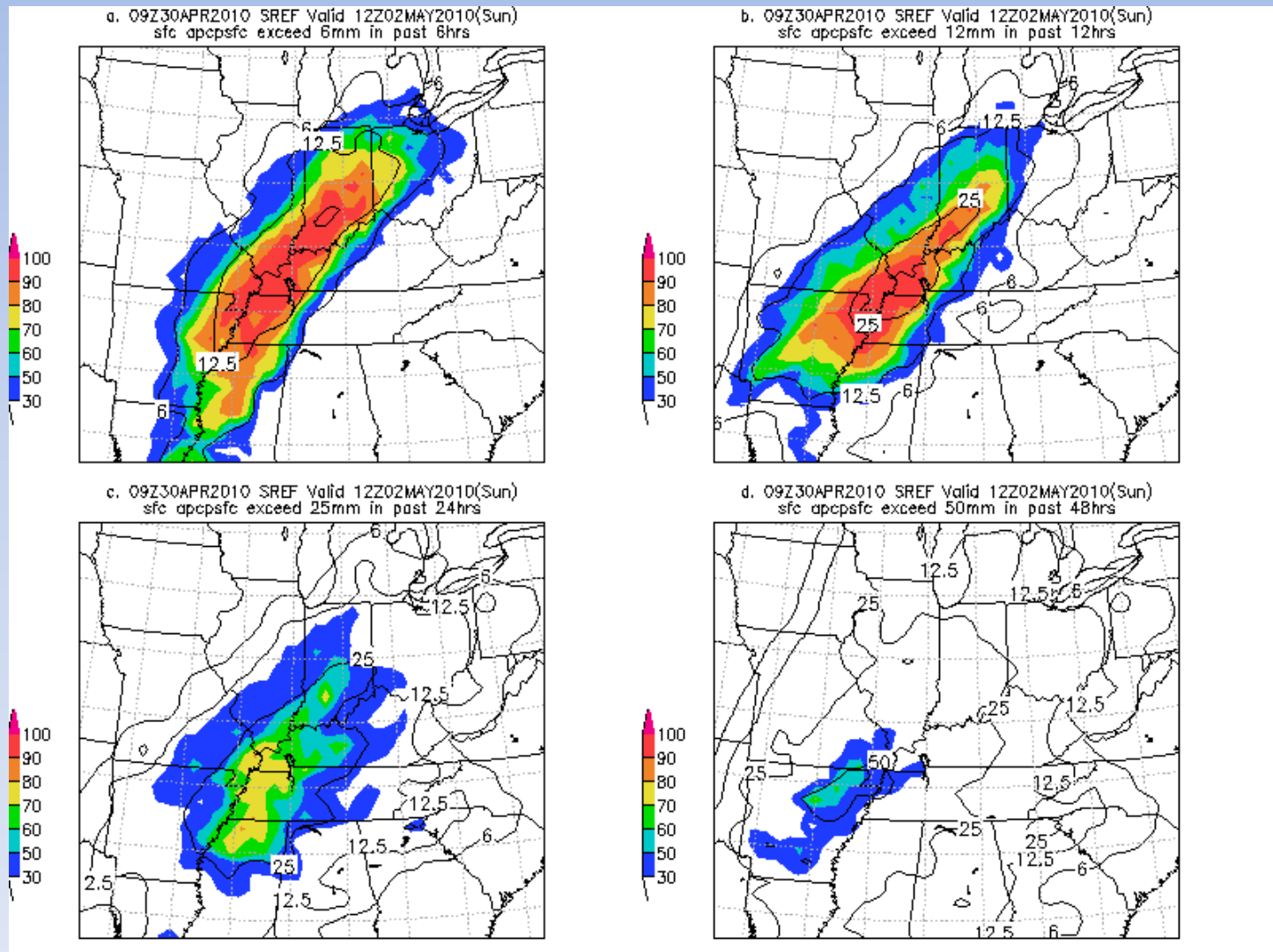
c.09Z30APR2010 SREF wind 850
Valid 12Z02MAY2010-12Z02MAY2010



d.09Z30APR2010 SREF prwatcm 1000
Valid 12Z02MAY2010-12Z02MAY2010



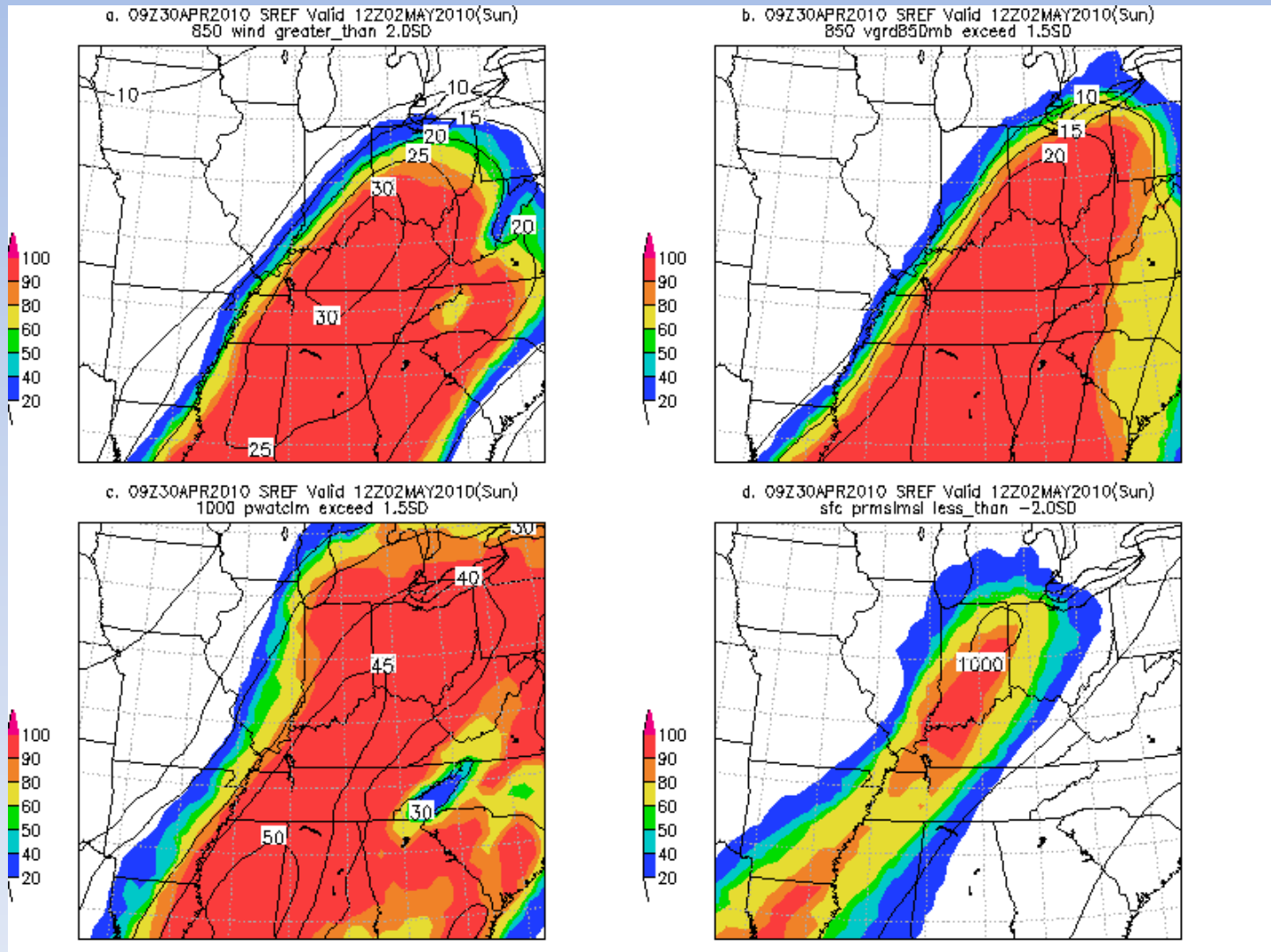
Where it rains, when it rains and how much it rains



Previous QPFs show heavy rainfall potential

- High probability of heavy rainfall in Mid-Mississippi Valley
 - Other thresholds would be good
 - Fairly long range location could shift!
- We need reinforcing regional data
 - Pattern and key parameters conducive for heavy rainfall?
 - Anomalies for context (significant event)
 - Ensembles for confidence in the pattern
- Things we do not know
 - Internal system QPF climatology
 - What is a 80, 90% or record rainfall in the SREF, GEFS, NAM?
 - Do you have a “feel” for this?

Rainfall and Heavy Rainfall from High Probability Anomalous Pattern



Persistent Surges in High PW Air and Strong Low-level Winds

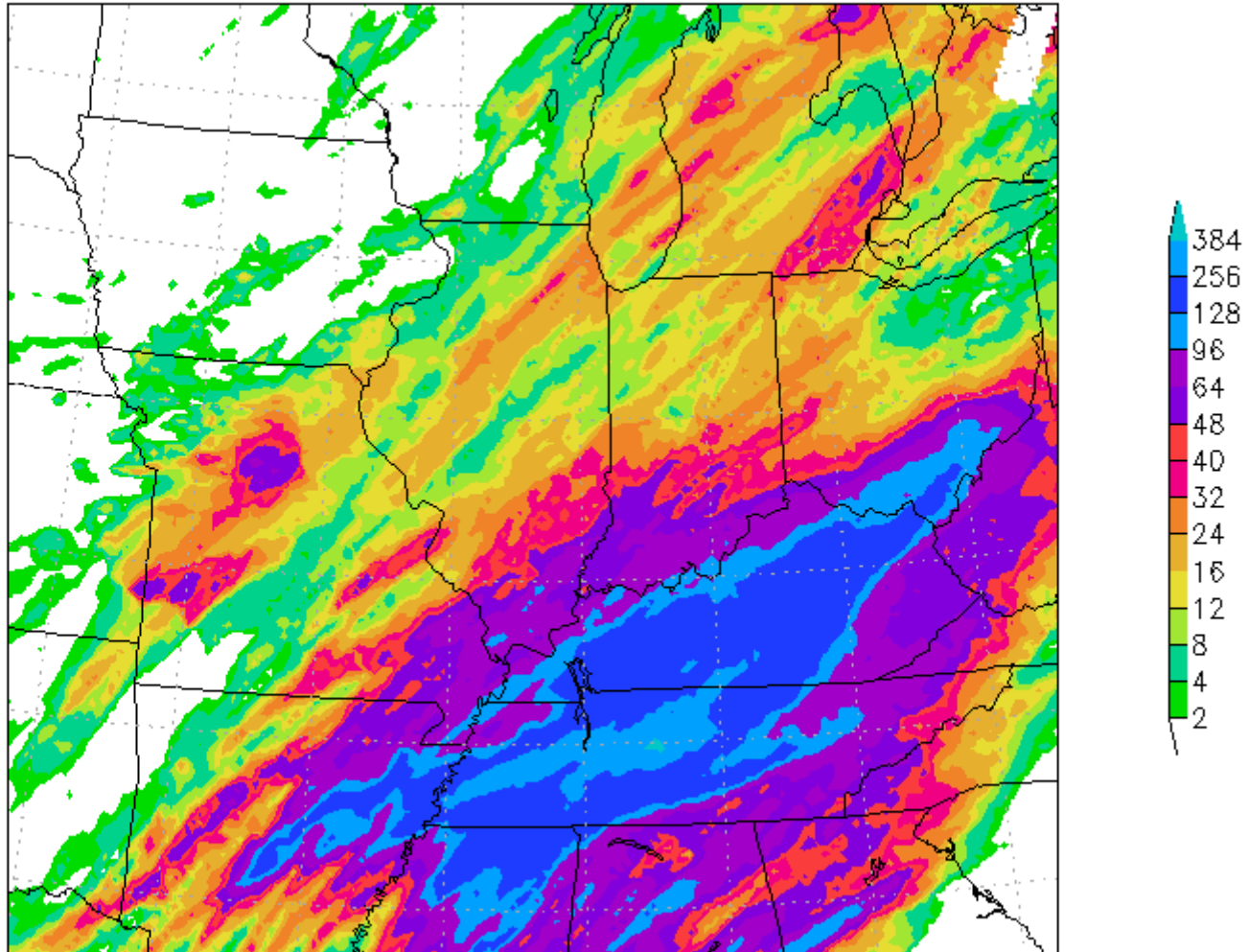
- Large scale pattern showed common event type
 - Anomalous trough-ridge and surging AR into MMV
 - This pattern forecast to persist for over 24 hours
- SREF showed high probability relatively heavy rainfall
- Regional scale anomalies
 - Put this pattern into **context** with confidence based on high probabilities of anomalous pattern
 - Enduring period of anomalous PW and V-winds into region → Confidence in heavy rainfall
- Anomalies for context and Ensembles for confidence
 - Some reinforcing data (GFS/GEFS/NAM)

The Simple Anomaly Context

Pattern	Event Type	Anomalies
Moisture plumes ("Atmospheric Rivers")	High end heavy rain	2 to 4 σ PW
Strong poleward flow	Synoptic	3-5 σ v-wind
Strong easterly flow	TC or Frontal	3-5 σ u-wind
Simplistically high moisture/High wind	Big rainfall Extreme	2 to 4 σ Moisture Flux 5 to 6 σ Moisture Flux

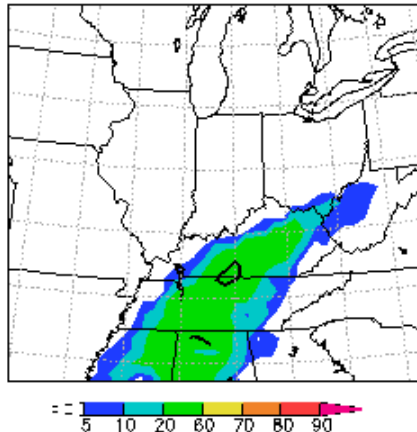
Estimated Rainfall (Stage IV Data Verification)

a. Accumulated liquid equivalent precipitation (mm)
from 00Z01MAY2010 to 12Z03MAY2010

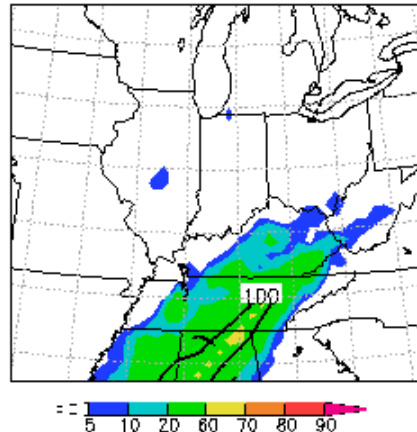


SREF Probability of 2,3 and 4 inches

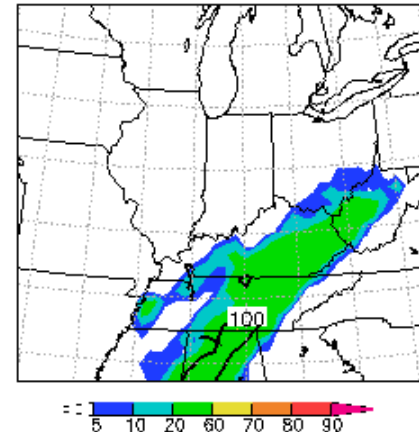
a.09Z30APR2010 SREF Prob of 100mm apcpcfc 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



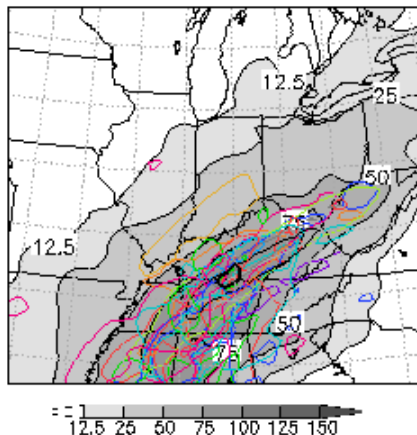
b.21Z30APR2010 SREF Prob of 100mm apcpcfc 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



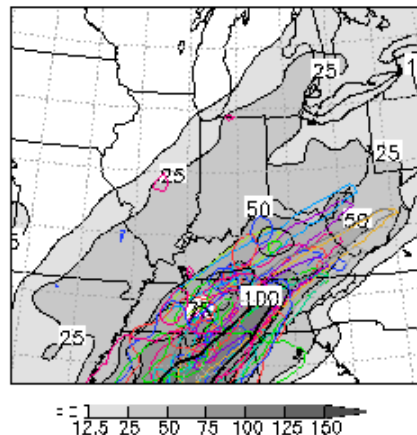
c.09Z01MAY2010 SREF Prob of 100mm apcpcfc 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



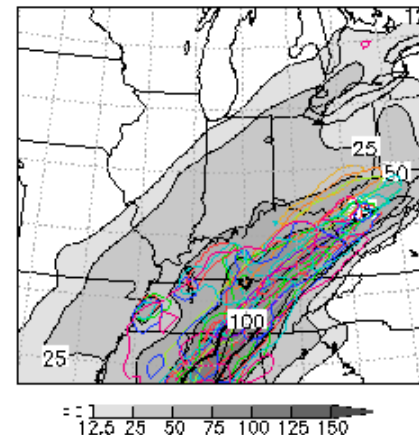
e.09Z30APR2010 mean GPF & 100mm contours 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



f.21Z30APR2010 mean GPF & 100mm contours 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



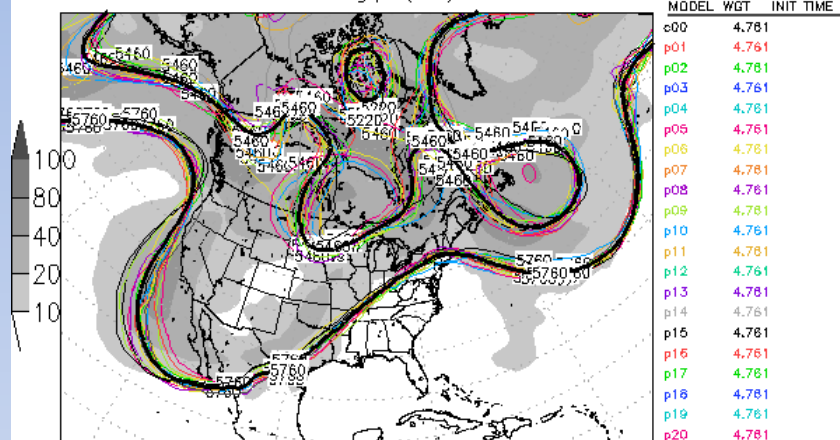
g.09Z01MAY2010 mean GPF & 100mm contours 48-h
Valid 12Z01MAY2010 to 12Z03MAY2010 Mon



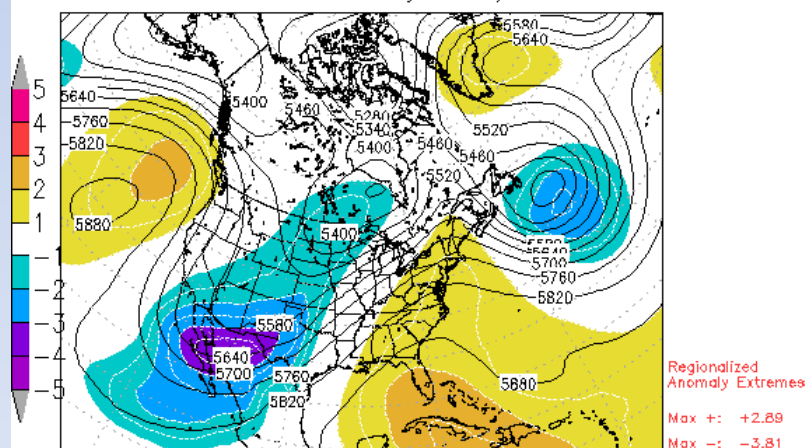
GEFS 500 and PW forecasts

Established heavy rainfall pattern → funnel down

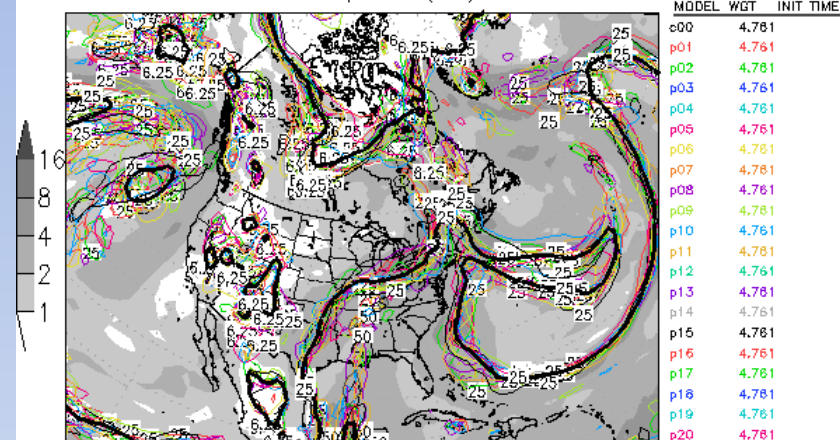
a. 12Z28APR2010 GEFS Valid 00Z02MAY2010 (Sun)
500hPa hgtrps(ens)



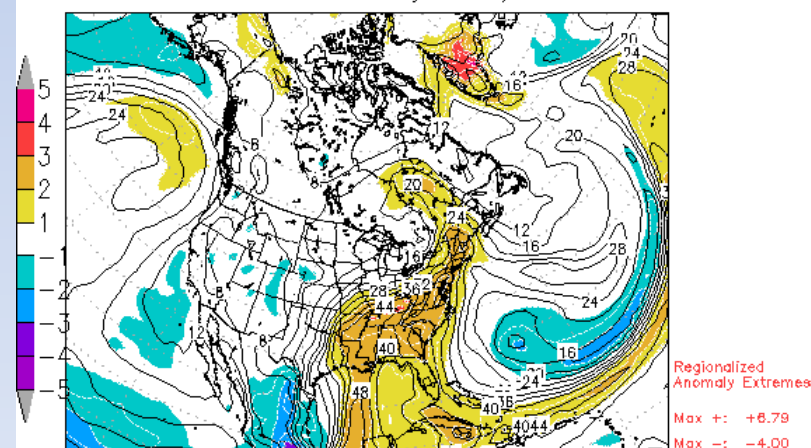
b. GEFS Consensus Forecast (contour) &
Normalized Anomaly shaded)



a. 12Z28APR2010 GEFS Valid 00Z02MAY2010 (Sun)
1000hPa pwatcm(ens)



b. GEFS Consensus Forecast (contour) &
Normalized Anomaly shaded)



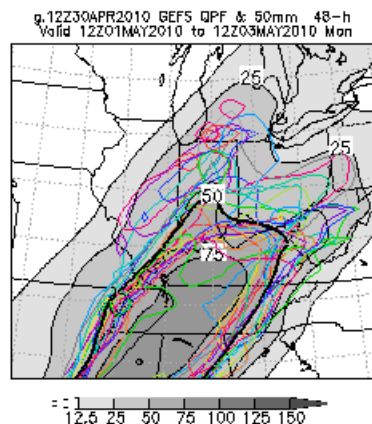
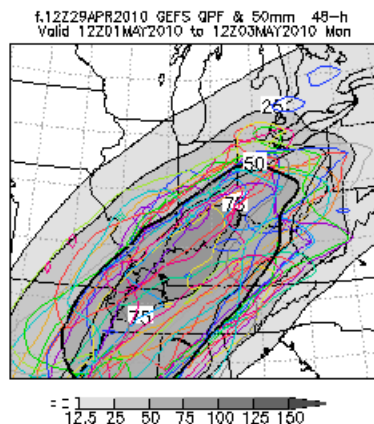
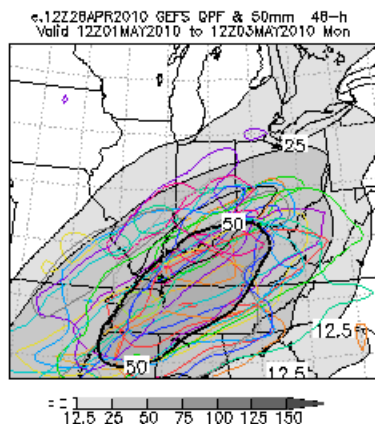
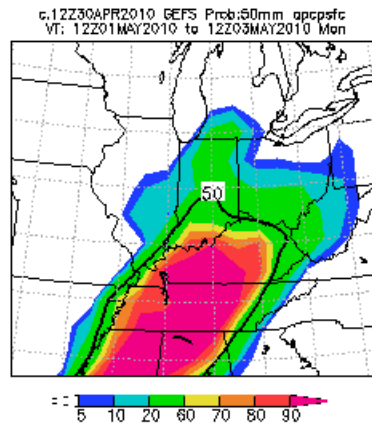
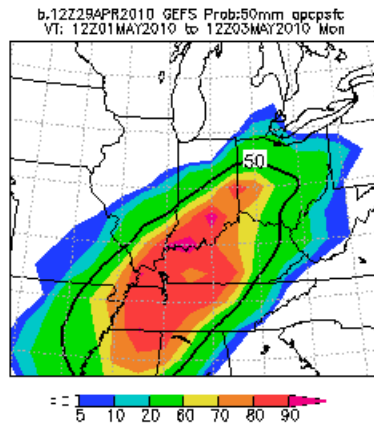
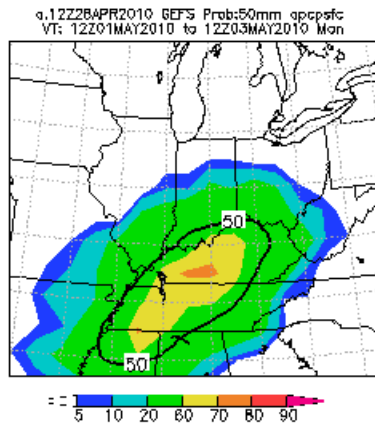
GEFS 500 and PW forecasts

Established heavy rainfall pattern → funnel down

- Great Pattern and zoom in focused over MMV
 - Plume high PW air
 - Though not shown winds were anomalous too
- Key role flow about anomalous ridge and trough
 - Funnel approach is helpful (extremely)
 - Leverage synoptic and pattern skill → anomaly context
 - Zoom into to get detail and region of impact
 - Works great for synoptic forced and widespread events

Tie in Patterns and Probabilities

GEFS runs 12Z 28-30 April 2010 48 hr QPF VT00Z 3 May 2010

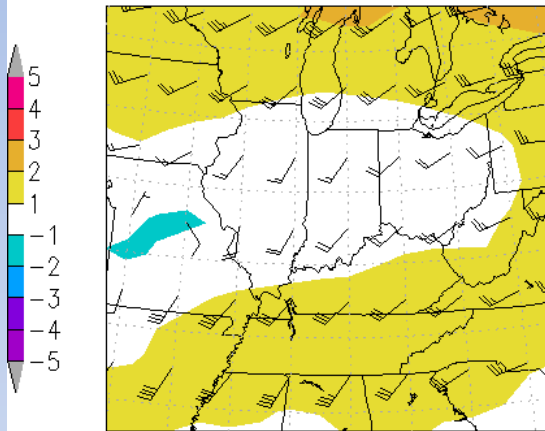


- 3 runs 24 hours apart
 - Latter more skillful
- Exceedance
 - 50, 75, 100 mm
 - 2,3, 4 inches
- GEFS 75km
 - What is a big QPF in the GEFS? GFS? SREF?
- Pattern for heavy rain
- Probability big QPF
- **Patterns & Probabilities**

Successive Forecast High PW

High PW air and strong low-level winds → High QPF

a. 12Z28APR2010 GEFS Valid 00Z02MAY2010 (Sun)
850hPa ugrdprs



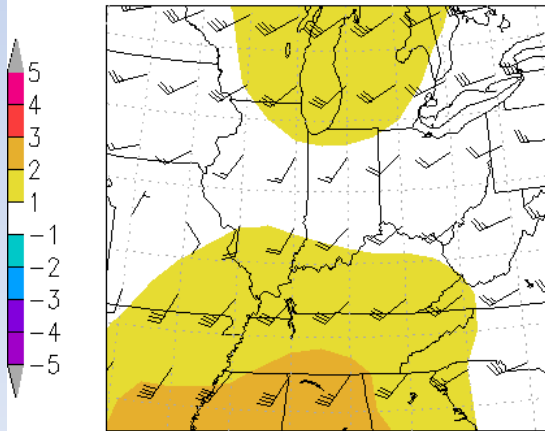
Ensemble
Components:

MODEL	INIT TIME
c00	12Z28APR2
p01	12Z28APR2
p02	12Z28APR2
p03	12Z28APR2
p04	12Z28APR2
p05	12Z28APR2
p06	12Z28APR2
p07	12Z28APR2
p08	12Z28APR2
p09	12Z28APR2
p10	12Z28APR2
p11	12Z28APR2
p12	12Z28APR2
p13	12Z28APR2
p14	12Z28APR2
p15	12Z28APR2
p16	12Z28APR2
p17	12Z28APR2
p18	12Z28APR2
p19	12Z28APR2
p20	12Z28APR2

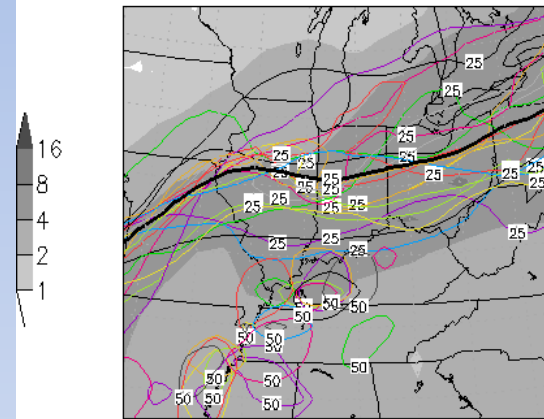
Ensemble
Component
Weighting:

MODEL	WEIGHT (%)
c00	4.761
p01	4.761
p02	4.761
p03	4.761
p04	4.761
p05	4.761
p06	4.761
p07	4.761
p08	4.761
p09	4.761
p10	4.761
p11	4.761
p12	4.761
p13	4.761
p14	4.761
p15	4.761
p16	4.761
p17	4.761
p18	4.761
p19	4.761
p20	4.761

b. 12Z28APR2010 GEFS Valid 00Z02MAY2010 (Sun)
850hPa vgrdprs



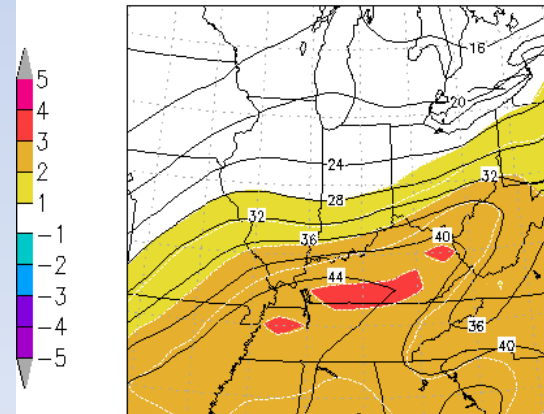
a. 12Z28APR2010 GEFS Valid 00Z02MAY2010 (Sun)
1000hPa pwtclm(ens)



Ensemble
Components:

MODEL	WGT	INIT TIME
c00	4.761	
p01	4.761	
p02	4.761	
p03	4.761	
p04	4.761	
p06	4.761	
p06	4.761	
p07	4.761	
p08	4.761	
p09	4.761	
p10	4.761	
p11	4.761	
p12	4.761	
p13	4.761	
p14	4.761	
p15	4.761	
p16	4.761	
p17	4.761	
p18	4.761	
p19	4.761	
p20	4.761	

b. GEFS Consensus Forecast (contour) &
Normalized Anomaly shaded



Regionalized
Anomaly Extremes

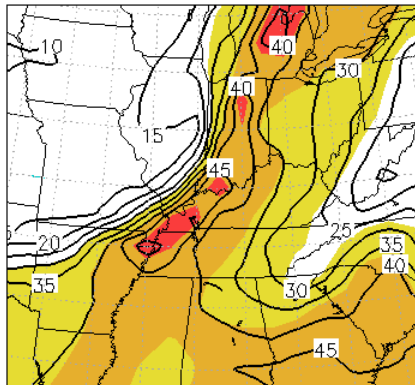
Max +: +3.11
Max -: -1.07

Deterministic High Resolution Models

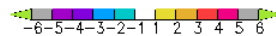
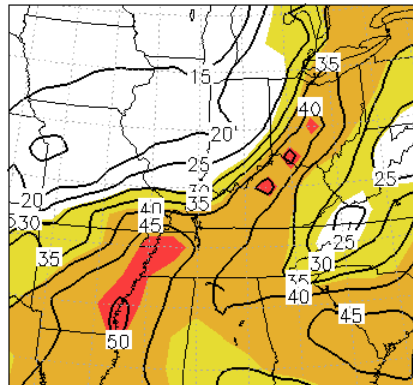
- Larger anomalies
 - One model and no averaging uncertainty information is lost
 - Finer scale verse our EFS and climatology
- Higher resolution
 - Aids in predicting the potential for higher end events
 - Extremely useful extremes and valuable at shorter ranges

GFS Regional Pattern and Anomalies with QPF

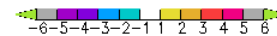
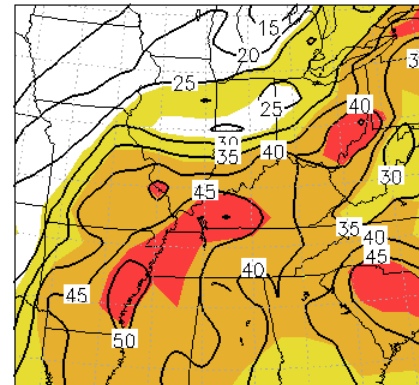
a.GFS 1000 hPa pwatclm VT:12Z01MAY2010
INIT: 12Z30APR2010



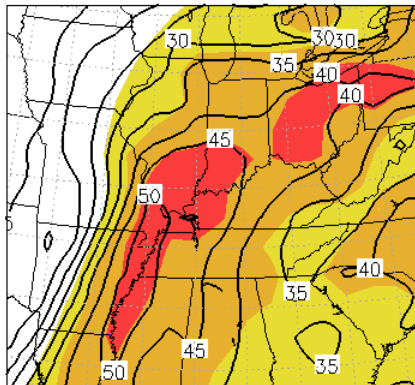
b.GFS 1000 hPa pwatclm VT:18Z01MAY2010
INIT: 12Z30APR2010



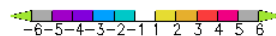
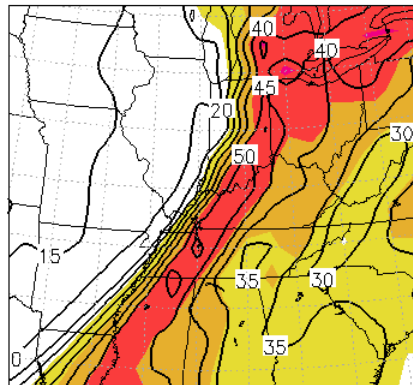
c.GFS 1000 hPa pwatclm VT:00Z02MAY2010
INIT: 12Z30APR2010



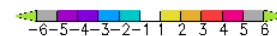
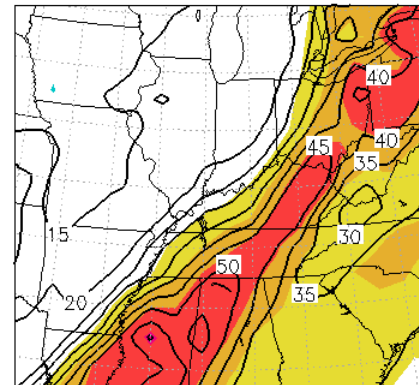
d.GFS 1000 hPa pwatclm VT:06Z02MAY2010
INIT: 12Z30APR2010



e.GFS 1000 hPa pwatclm VT:12Z02MAY2010
INIT: 12Z30APR2010



f.GFS 1000 hPa pwatclm VT:18Z02MAY2010
INIT: 12Z30APR2010



Deterministic High Resolution Models

- Show uncertainty when examined run-to-run
- Increase in value as forecast length decreases
 - Valuable shorter ranges strongly forced systems
- In 0-18 hour range→
 - 3-4 km models very useful and storm scale ensembles should help in ***strongly forced larger scale events***
- Limitations with more mesoscale events

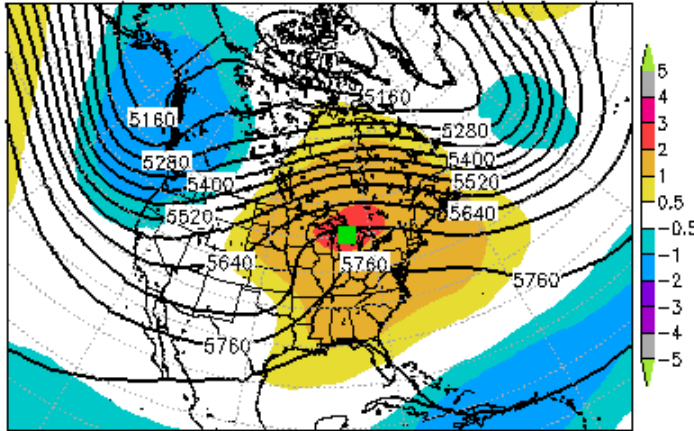
Limitations

Predictability is a hurdle we may never clear

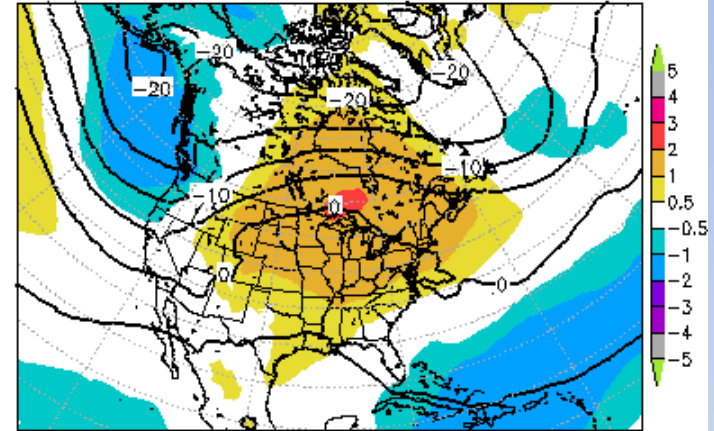
- Method good for pattern and pattern recognition
- Larger scale events with strong signal
 - Well predicted but not the exacting details and
 - Not the exact region errors of ~100km are typical
- Mesoscale events (Chicago Flood 2011 example)
 - Pattern may look generally good
 - NWP has limited ability to predict locally heavy rainfall
 - Storm scale models & ensembles may help 0-12 hours
 - Problem is the hardest to deal with → job security!
 - Use patterns and MET_WATCH in these cases

Pattern for record warm 9 days and 2 days and 1 time period

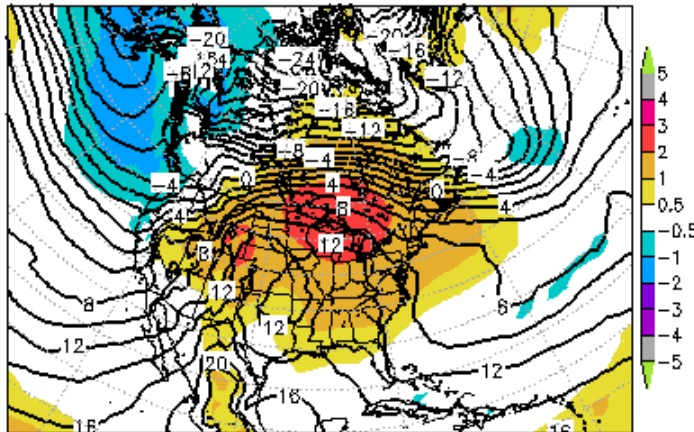
a. Composite 500hPa hgtprs 00Z13MAR2012–00Z24MAR2012
INIT: 00Z01MAR2012



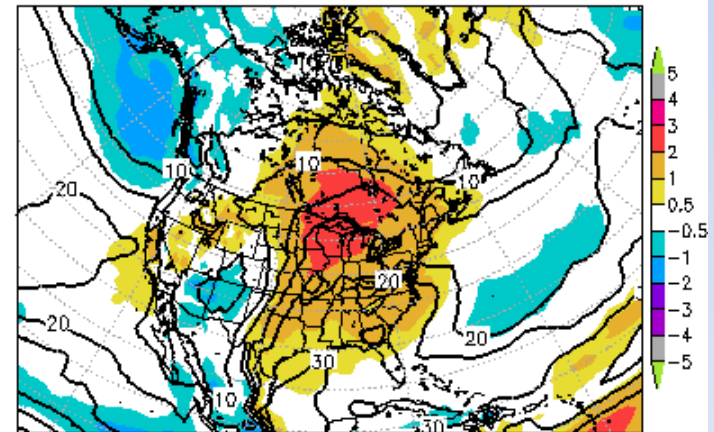
b. Composite 700hPa tmprsr 00Z13MAR2012–00Z24MAR2012
INIT: 00Z01MAR2012



c. Composite 850hPa tmprsr 00Z13MAR2012–00Z24MAR2012
INIT: 00Z01MAR2012



d. Composite 1000hPa pwatclm 00Z13MAR2012–00Z24MAR2012
INIT: 00Z01MAR2012



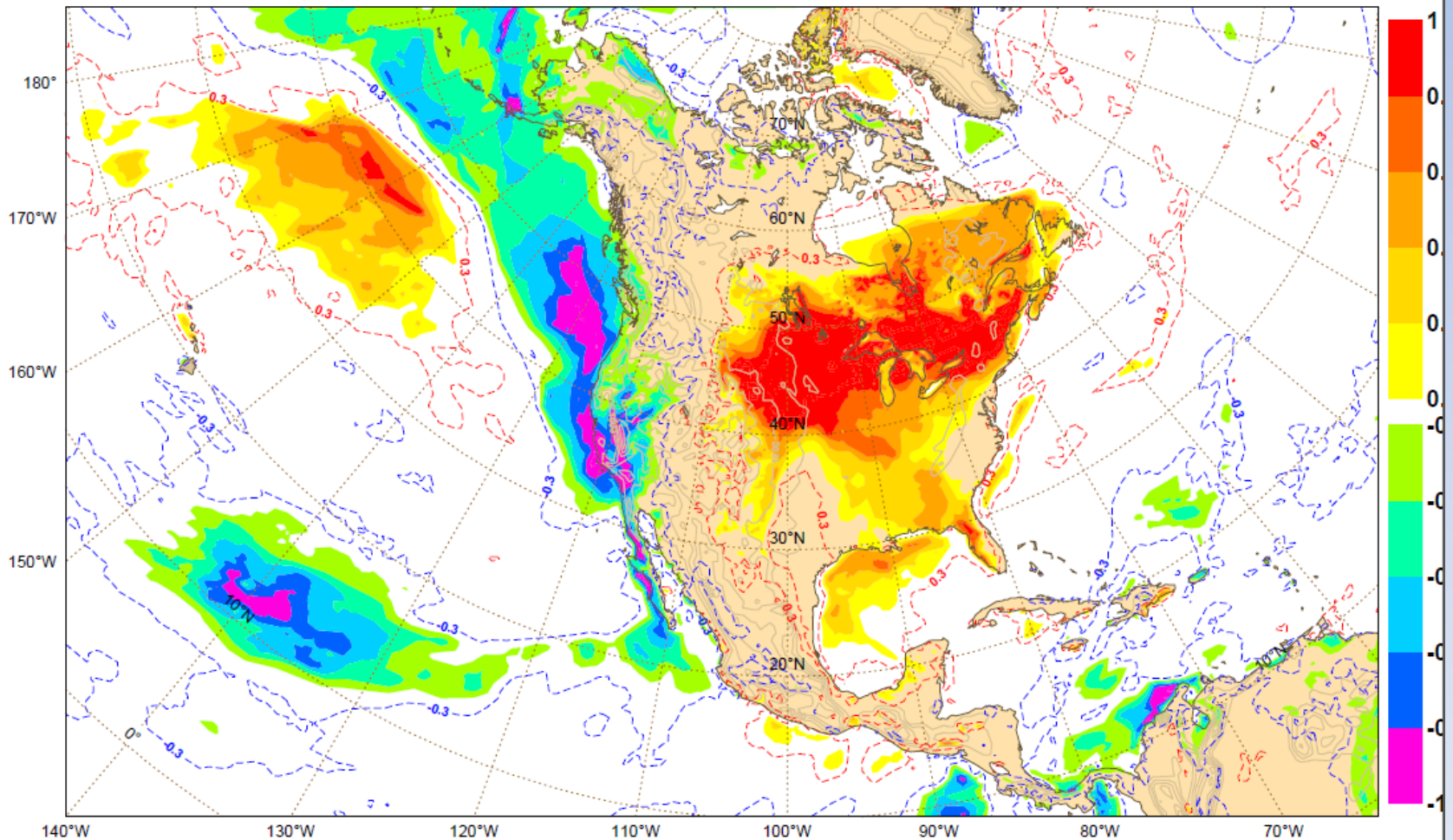
Threats and Extreme Forecast Indices (EFI)

- **Threats** → Probabilities of key parameters exceeding critical thresholds to alert forecaster to outcomes... Can R-Climate based or critical probabilities (SPC does this)
- **EFI** → Alarm bells based on exceeding internal ensemble climatology (M-Climate) or re-analysis climatology (R-Climate)

M-Climate Based EFI

Record high and high minimum temperatures

Sunday 18 March 2012 00UTC @ECMWF VT: Sun 18 Mar 2012 00UTC - Mon 19 Mar 2012 00UTC 0-24h
Extreme forecast index for: 2m maximum temperature



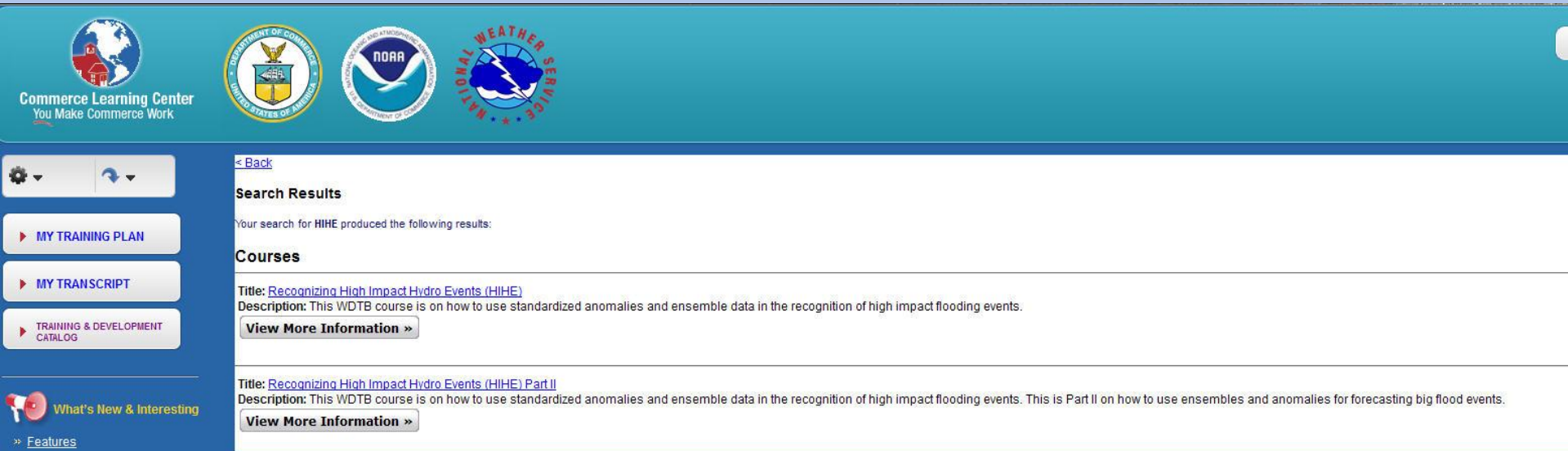
Review

Patterns and Probabilities → HIHE

- Leverage ensemble **confidence information**
 - In the pattern and the persistence of the pattern associated with heavy rain
 - And the probabilities for excessive rainfall
 - To Produce forecasts of heavy or heavy/excessive rain
- Leverage Anomaly information
 - Put known patterns into context → identify HIHE!
 - Provide some information on predictability
- Future →
 - New climatology being derived but we need internal model climate
 - Data into AWIPS
 - More probabilities focused on the threats

Recognizing High Impact Hydro Events

Online Course Information



The screenshot displays the Commerce Learning Center interface. The top header features logos for the Commerce Learning Center, the U.S. Department of Commerce, NOAA, and the National Weather Service. The left sidebar contains navigation buttons: 'MY TRAINING PLAN', 'MY TRANSCRIPT', and 'TRAINING & DEVELOPMENT CATALOG'. Below these is a 'What's New & Interesting' section with a 'Features' link. The main content area shows search results for 'HIHE'. It includes a '< Back' link, a 'Search Results' heading, and a message: 'Your search for HIHE produced the following results:'. Under the 'Courses' heading, two results are listed. The first result has the title 'Recognizing High Impact Hydro Events (HIHE)' and a description: 'This WDTB course is on how to use standardized anomalies and ensemble data in the recognition of high impact flooding events.' It includes a 'View More Information >>' button. The second result has the title 'Recognizing High Impact Hydro Events (HIHE) Part II' and a description: 'This WDTB course is on how to use standardized anomalies and ensemble data in the recognition of high impact flooding events. This is Part II on how to use ensembles and anomalies for forecasting big flood events.' It also includes a 'View More Information >>' button.

Commerce Learning Center
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U.S. DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NATIONAL WEATHER SERVICE

< Back

Search Results

Your search for HIHE produced the following results:

Courses

Title: [Recognizing High Impact Hydro Events \(HIHE\)](#)
Description: This WDTB course is on how to use standardized anomalies and ensemble data in the recognition of high impact flooding events.
[View More Information >>](#)

Title: [Recognizing High Impact Hydro Events \(HIHE\) Part II](#)
Description: This WDTB course is on how to use standardized anomalies and ensemble data in the recognition of high impact flooding events. This is Part II on how to use ensembles and anomalies for forecasting big flood events.
[View More Information >>](#)

What's New & Interesting
>> [Features](#)

Log into NWS Learn Center (<https://doc.learn.com/noaa/nws>)

Use Search Tool (“**HIHE**”) in Training and Development Catalog

WDTB HIHE Course Website

<http://www.wdtb.noaa.gov/courses/hydro>

Course Completion Instructions:

1. Complete the pre-requisites for the course:
 - o AWOC IC Severe 1 (Conceptual Models) - Lesson 3: [Flash Flooding](#)
 - o Flash Flood Warning Best Practices - Part 3: [The Meteorology Behind Extreme Rain Events](#)
2. Review optional material that can better your understanding of QPF, NWP models, precipitation estimation, hydrology, and streamflow prediction. A list of relevant material can be found on the [Review Page](#).
3. Complete all lessons in **Recognizing High Impact Hydro Events** course, including the case exercises.
4. Complete the course assessment on the [LMS Web Page](#).

Course Outline:

Use the tabs below to view the details on each part of this course. You have the ability to view or download the presentations and exercises from here. Remember to login to the LMS to receive credit for the Course and the Case Exercises.

Overall Course Duration: 140 minutes

Part 1: On the Value of Anomalies

Part 2: Ensembles and Anomalies

Part 3: Case Exercises

Service

ing Branch

News

High Impact Hydro
Events



tion of severe weather in the United States over
air follow-up statements are some of the most
Service (NWS). Issues with these products
I public and our partners, and result in
s and recommendations have been made
warning practices documented in some of
a [Southeast United States Floods of
of Greater Nashville: Including Flooding in
lay 1-4, 2010](#) assessments.

educational Plan (NSTEP), the NWS Warning
id training on recognizing and forecasting
js on synoptic pattern recognition and the use
ng large-scale quantitative precipitation
are intended to help the warning forecaster

provide guidance to local training officers and
se and implementation of this course. This
dation 12 of the Record Floods of Greater
see and Western Kentucky of May 1-4, 2010

Performance Objectives for Course:

LMS Course

Recognizing High Impact Hydro Events (HIHE)



Exit Edit Next

Recognizing High
Impact Hydro
Events (HIHE)

Recognizing High
Impact Hydro Events

Introduction

Part 1

Part 2

Part 3

Important lesson navigation buttons "Next" and "Exit" are in the middle of your web browser window, just above this line.

Welcome to Recognizing High Impact Hydro Events

Introduction

This Web-based Training course is on recognizing and forecasting extreme rainfall events. Course material focuses on synoptic pattern recognition and the use of standardized anomalies to assist in forecasting quantitative precipitation forecasts (QPFs). The Course is composed of 3 Parts. Part 1 is on the value of anomalies, showing how they can help put known patterns in context. Part 2 demonstrates how to leverage ensemble and anomaly data to provide the confidence information to forecast high impact rainfall and flood events. Part 3 consists of two Case Exercises that allow forecasters the opportunity to apply the concepts and gain expertise by analyzing data and answering questions about the Cases.

Learning Objectives: Upon completion of these lessons, you will be able to

- 1) Identify the role of antecedent conditions in flood events.
- 2) Show how well standardized anomalies aid in identifying the potential for heavy rain and flooding.
- 3) Recognize the limits of standardized anomalies in the forecast process and in heavy rainfall events.
- 4) Show how standardized anomalies and ensembles can provide confidence in forecasting flood events.

Duration: 15 min. for Part 1, 20 min. for Part 2, 2 hours for Part 3.

How to Complete This Course



1. Hit **"Next"** to go to the first part of this course. There are three pages altogether.
2. Click **"Launch Presentation"** on each section of the course. Web modules open in a new window. Presentations can be paused and restarted at any point.
3. **Return to complete the exam:** After the last page, which contains web links to the Case Exercise Interface, the "Next" button will take you to the test. You must score at least 70%. You can retake the test if necessary by relaunching the course from "My Training Plan" page or your Development Plan (if appropriate).
4. **Complete the survey:** Hit "Next" after the test to complete the survey to help us improve this course.
5. **Record your completion:** Be sure to use the "Exit" button just above these instructions to receive credit for completing this course!



Exit Edit Next

Equal Credit for Completing Live Webinars or Online Course

1 hour Webinar



Recognizing High Impact Hydro Events Special Webinar I

Wednesday, May 9, 2012
1:00 PM - 2:00 PM CDT

REGISTER NOW



Join us for a Webinar on May 9

This is a special webinar for the Recognizing High Impact Hydro Events training module produced by WDTB featuring Richard Grumm. This webinar will show techniques for recognizing and forecasting extreme rainfall events. Information presented in the live session will focus on synoptic pattern recognition and the use of standardized anomalies to assist in forecasting large-scale quantitative precipitation forecasts (QPFs).

Reserve Your Webinar Seat Now at:
<https://www1.gotomeeting.com/register/245455616>

2.5 hrs self-paced Online Course

Recognizing High Impact Hydro Events (RHIE)

Important lesson navigation buttons "Next" and "Exit" are in the middle of your web browser window, just above this line.

Welcome to Recognizing High Impact Hydro Events

Introduction

This Web-based Training course is on recognizing and forecasting extreme rainfall events. Course material focuses on synoptic pattern recognition and the use of standardized anomalies to assist in forecasting quantitative precipitation forecasts (QPFs). The Course is composed of 3 Parts. Part 1 is on the value of anomalies, showing how they can help put known patterns in context. Part 2 demonstrates how to leverage ensemble and anomaly data to provide the confidence information to forecast high impact rainfall and flood events. Part 3 consists of two Case Exercises that allow forecasters the opportunity to apply the concepts and gain expertise by analyzing data and answering questions about the Cases.

Learning Objectives: Upon completion of these lessons, you will be able to

- 1) Identify the role of antecedent conditions in flood events.
- 2) Show how well standardized anomalies aid in identifying the potential for heavy rain and flooding.
- 3) Recognize the limits of standardized anomalies in the forecast process and in heavy rainfall events.
- 4) Show how standardized anomalies and ensembles can provide confidence in forecasting flood events.

Duration: 15 min. for Part 1, 20 min. for Part 2, 2 hours for Part 3.

How to Complete This Course

1. Hit "Next" to go to the first part of this course. There are three pages altogether.
2. Click "Launch Presentation" on each section of the course. Web modules open in a new window. Presentations can be paused and restarted at any point.
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4. Complete the survey: Hit "Next" after the test to complete the survey to help us improve this course.
5. Record your completion: Be sure to use the "Exit" button just above these instructions to receive credit for completing this course!

Thanks



References

Bodner, M.J., N.W Junker, R.H. Grumm and R.S Schumacher 2011: Comparison of Atmospheric Circulation Patterns during the 2008 and 1993 Historic Midwest floods. NWA, December 2011.

Junker, N.W., R.H. Grumm, R.H. Hart, L.F Bosart, K.M. Bell, and F.J. Pereira, 2008: Use of normalized anomaly fields to anticipate extreme rainfall in the mountains of northern California. *Wea. Forecasting*, **23**, 336-356.

-----, M.J. Brennan, F. Pereira, M.J. Bodner, and R.H. Grumm, 2009: Assessing the Potential for Rare Precipitation Events with Standardized Anomalies and Ensemble Guidance at the Hydrometeorological Prediction Center. *Bull. Amer. Meteor. Soc.*, **90**, 445–453.

Maddox, R.A., C.F Chappell, and L.R. Hoxit. 1979: Synoptic and meso-alpha aspects of flash flood events. *Bull. Amer. Meteor. Soc.*, **60**, 115-123

EFI Papers:

Lalurette, F. 2003: Early Detection of abnormal weather conditions using a probabilistic extreme forecast index. Q.J.R. Meteorol. Soc. 129, 3037-3057. (See ECMWF Tech Memo 373)

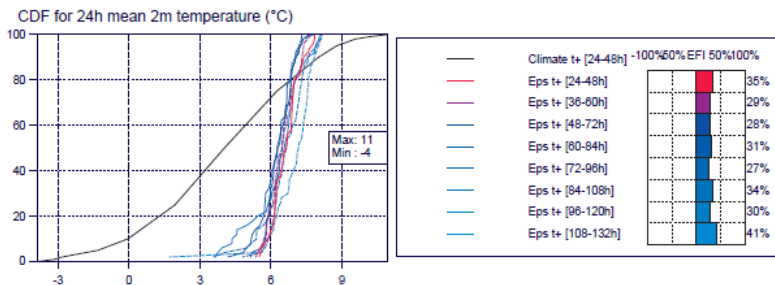
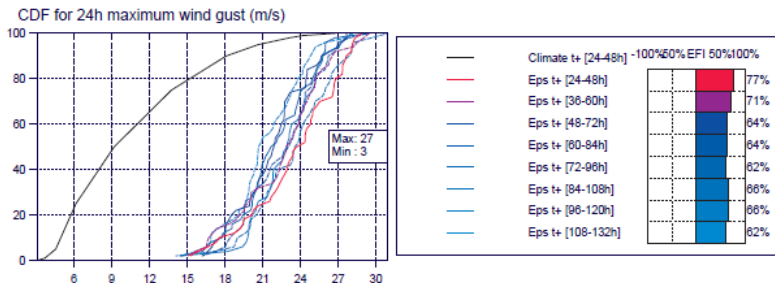
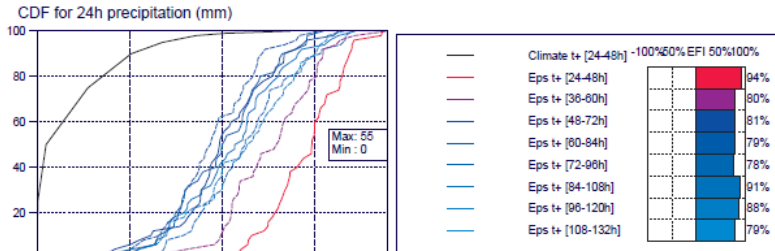
Legg T.P. and K.R. Mylne, 2004: Early Warnings of severe weather from ensemble forecast information. *Wea. Forecasting*, **19**, 891-906.

Palmer, T.N. 2002, The Economic value of ensemble forecasts as a tool for risk assessment: From days to decades. Q.J.R. Meteorol. Soc. 128, 747-774.

EFI at a Point

Visualize CDF of model and forecast cycles

Forecast and M-Climate cumulative distribution functions with EFI values at 43.4°N/123.43°W
valid for 24 hours from Thursday 19 January 2012 00 UTC to Friday 20 January 2012 00 UTC



Max: 11
Min: -4
24-48h M-Climate extrema

M-Climate: this stands for "Model Climate". It is a function of lead time, date (+/- ~15 days), and model version. It is derived by rerunning a 5 member ensemble, over the last 18 years, once a week (450 realisations). M-Climate is always from the same model version as the displayed EPS data. On this page only the 24-48h lead M-Climate is displayed.

- January 2012 cold, wind and snow western United States
- Look at QPF upper panel
 - All members show for all runs show generally higher QPF then in the M-Climate
 - EFS is predicting extreme rainfall for this point
 - Model forecast near record QPF internally is valuable information!**
- Winds show same effect
 - Winds are forecasting winds higher than M-Climate by most members